

10/589258

IAP11 Rec'd PCT/PTO 11 AUG 2006

5       Cutting tool and insert with serrated contact surfaces  
          between holder and insert.

Technical Field of the Invention

10       In a first aspect, this invention relates to a  
cutting tool intended for chip-removing machining of the  
type that comprises, on one hand, a basic body having an  
insert seat, and on the other hand a cutting insert, which  
is detachably connected in the insert seat and rigidly  
secured in the same by means of connecting surfaces of  
serration type, one of which forms said insert seat and  
15       comprises first and second ridges, which extend  
perpendicularly to each other.

20       In practice, the basic body may consist of, for  
instance, a drill shank or a cutter head, and the cutting  
insert of an indexable cutting insert.

Prior Art

25       A cutting tool of the above-mentioned type is  
previously known by WO 9900208 A1. In this case, the  
serration connecting surface serving as insert seat  
comprises two sets of ridges, which each are located in a  
separate surface field. This disposition of the ridges in  
only two sets or surface fields leads to the disadvantage  
that the cutting forces, which act on the cutting insert,  
are not distributed in a desirable, even way along the  
30       entire area of the connecting surface; something which  
means that the ability of the connecting surface to carry  
and resist large forces becomes limited. In, for instance,  
four-edged cutting inserts of the type that are indexable  
in four positions, the corner of the cutting insert that is  
35       indexed forward to an active position, accordingly, gets a  
tendency to be displaced; something which among other  
things may lead to mediocre machining precision as a  
consequence of the cutting insert being dislodged from the  
desired position thereof.

Objects and Features of the Invention

The present invention aims at obviating the above-mentioned disadvantages of the previously known cutting tool and at providing an improved cutting tool. Therefore, a primary object of the invention is to provide a cutting tool, the serration connection of which between the basic body and a cutting insert guarantees an even and reliable distribution of the cutting forces acting on the cutting insert along the entire surface extension of the connection. It is also an object to provide a cutting tool, the serration connection of which - for a given tool dimension - can carry larger forces than the previously known serration connection, without being dislodged from the fixed, exact position thereof.

According to the invention, these objects are attained by means of the features defined in the characterizing portion of claim 1.

In a second aspect, the invention also relates to a basic body as such intended for cutting tools. The features of the basic body according to the invention are seen in the independent claim 2. Preferred embodiments of the basic body according to the invention are further defined in the dependent claims 3-7.

In a third aspect, the invention also relates to a cutting insert as such intended for cutting tools. The features of this cutting insert are seen in the independent claim 8.

Brief Description of the Appended Drawings

In the drawings:

Fig. 1 is a simplified perspective view showing a cutting tool, the basic body of which consists of a cutter head having an insert seat, in which a cutting insert is fixed,

Fig. 2 is an end view showing the interface between the cutting insert and the insert seat on an enlarged scale,

11977wo 2005-02-21

3

Fig. 3 is an enlarged, perspective exploded view showing the insert seat as well as the bottom side of the cutting insert,

Fig. 4 is a schematic perspective view of an insert seat according to the invention,

Fig. 5 is a perspective exploded view showing an alternative embodiment of a serration connection between a cutting insert and an insert seat, and

Fig. 6 is a perspective view from below of a cutting insert according to the invention.

#### Detailed Description of Preferred Embodiments of the Invention

In fig. 1, a rotatable cutting tool is shown exemplified as a milling cutter, which comprises a basic body 1, in the form of a cutter head, as well as a number of cutting inserts 2. For the sake of simplicity, only one such cutting insert is shown, although milling cutters in practice are provided with a plurality of peripheral and tangentially spaced cutting inserts. The individual cutting insert 2 is mounted in an insert seat designated 3, which is formed adjacent to a chip pocket 4 in the periphery of the basic body 1. The insert seat 3 consists of a first connecting surface of serration type, which is arranged to co-operate with a second serration connecting surface 5 (see figs. 2 and 3), which is formed on the bottom side of the cutting insert 2. The cutting insert 2 is fixed in the insert seat 3 by means of a suitable clamping member, which in the example consists of a screw 6, but which also may consist of a clamp or the like.

Before the two serration connecting surfaces 3, 5 are described closer, the general shape of the basic body 1 as well as of the cutting insert 2 should be briefly described. In the chosen example, the cutting insert 2 (see figs. 2 and 3) has a flat and quadrangular (square) basic shape, which is defined by generally planar and mutually parallel top and bottom sides 7, 8. Between these, four side surfaces 9 extend, which are similar and form

11977wo 2005-02-21

4

clearance surfaces adjacent to cutting edges 10, 11, which are formed between the top side 7 and the side surfaces 9.

The cutter head 1 serving as basic body (see fig. 1) has a ring-shaped front surface 12 and a rotationally symmetric envelope surface 13. Rearward from the main portion of the cutter head, a tapering portion 14 extends for the attachment in a tool holder. In fig. 1, 15 designates the corner of the cutting insert, which is indexed forward to an active position. In this state, the edge 10 forms a major cutting edge and the edge 11 a minor cutting edge or wiper edge. It is axiomatic that the corner 15 indexed forward is exposed to the major part of the forces acting on the cutting insert during operation, while the other three corners, which are inactive, are not exposed to any substantial stresses.

Each one of the connecting surfaces 3 and 5 comprises in a conventional way a number of ridges and/or tops, which are mutually spaced apart by grooves. In the same way as in WO 9900208 A1, the connecting surface 5 of the exemplified cutting insert 2 is waffle-patterned or chequered, so far that the same comprises pyramidal tops 16 arranged in rows, which are uniform and spaced apart by grooves 17, 17', which extend perpendicularly to each other. The serration connecting surface 3 serving as insert seat comprises two different kinds of ridges generally designated 18 and 19, respectively, which extend perpendicularly to each other in order to guarantee mechanical locking of the cutting insert in two directions perpendicular to each other. The grooves positioned between the ridges 18 are designated 22. The cross-section shape of the ridges is conventional so far that the individual ridge is delimited by two opposed flank surfaces or flanks 20 (see fig. 2), between which there is a crest 21, which forms the highest located portion of the ridge. Nearby ridges are laterally spaced apart by grooves 22, the bottoms of which are designated 23. A common angle between the flank surfaces 20 is 60°, although also other angles are feasible. It is essential that the crests of the ridges in one of the connecting surfaces do not bottom in the grooves in the other connecting surface. It is also

11977wo 2005-02-21

5

essential that the pitch between the ridges is the same in the two connecting surfaces, because otherwise one of the connecting surfaces would not be able to be fit into the other.

5 As far as the shown serration connection between the cutting insert and the insert seat has been described hitherto, the same is in all essentials previously known by WO 9900208 A1.

10 New and characteristic of the present invention is that at least the connecting surface 3, which forms an insert seat in the basic body, comprises, on one hand, two spaced-apart sets of a plurality of mutually parallel, first ridges 18, which are arranged in extension of each other, and on the other hand one or more second, transverse  
15 ridges 19, which are located between the two sets of first ridges. In fig. 4, a surface field, which comprises a first set of first ridges 18, is designated A, while a surface field spaced apart from the same and comprising a second set of first ridges 18 is designated B. As a consequence of  
20 this, the ridges in the first-mentioned field are designated 18A, while homologous ridges in the surface field B are designated 18B. Furthermore, in fig. 4, 15A designates the corner in the insert seat, toward which the active corner 15 of the cutting insert 2 is turned in fixed  
25 position.

Reference being made to fig. 1, it should be pointed out that the cutting insert 2 during operation is exposed to forces in three different directions in a conceived system of coordinates, namely tangential forces in the x  
30 direction, radial forces in the y direction and axial forces in the z direction. Of said forces, the radial forces in the y direction are considerably larger than the axial forces in the z direction.

Now reference is made again to fig. 4, which  
35 illustrates how the number of ridges 18A, 18B in the surface fields A, B is considerably larger than the number of transverse ridges or intermediate ridges 19. Thus, in the example, the number of ridges 18A and 18B, respectively, amounts to twelve, while the number of

11977wo 2005-02-21

6

transverse ridges 19 amounts to two. This means that the main part of the cutting forces acting on the cutting insert, namely the radial forces  $y$ , are carried by a large number of ridges via the force-transferring flanks thereof, the total area of which is many times larger than the total area of the flanks of the transverse ridges 19, which have the purpose of carrying the axial forces in the  $z$  direction. In this connection, it should be pointed out that surface contact for the transfer of force in the  $y$  direction essentially is established between, on one hand, the radially outwardly turned flank on each ridge 18A, 18B, and on the other hand the radially inwardly turned flank on each top 16 in the connecting surface 5 of the cutting insert. Surface contact for the transfer of force in the  $z$  direction, in turn, is established between, on one hand, the flank on each transverse ridge 19 that is facing the front surface 12 of the basic body, and on the other hand the flanks on the tops 16 of the waffle pattern that are turned away from said front surface. By the fact that the ridges 18 that should carry the dominant radial forces  $y$  are present not only adjacent to the corner 15A (in the surface field A), but also in the surface field B distanced from the corner in question, the capability of the connecting surface to resist the forces that aim to turn the cutting insert in relation to the insert seat, more precisely around a centre of rotation at the corner 15A, is radically improved.

#### Manufacture of the Tool

Of the two parts 1, 2, which together form the cutting tool, the basic body 1 is made from steel or the like, the serration connecting surface 3 being produced by precision machining, in particular milling, of the ridges and grooves that together form the surface in question. However, the individual cutting insert 2 is made by compression moulding and sintering of cemented carbide (or another material having considerably larger hardness and resistance to wear than steel), the connecting surface 5 on the bottom side of the cutting insert obtaining at least

11977wo 2005-02-21

7

the basic shape thereof in connection with the pressing and sintering. In practice, the cutting insert may either be of the directly pressed type, i.e., lack after-treatment, or be ground in order to attain high precision.

5           Milling of the serration connecting surface 3 shown in fig. 4 in the basic body may be carried out in various ways. One way is to initially produce the ridges 18A and 18B in two consecutive steps, between which an intermediate step is performed in which a milling cutter suitable for  
10           the purpose is raised in order to leave a central area on the cutting insert. For instance, the ridges 18A in the surface field A may first be formed by the milling cutter being brought in a horizontal plane. When the ridges have received the full length, the milling cutter is raised and  
15           jumps over or skips the central area, after which it once again is lowered down into the same plane as the first-mentioned one, in order to complete ridges 18B with the desired length. In another operation, another milling  
20           cutter, the shape of which is suitable for the provision of the transverse ridges 19, is brought along the bottom side of the cutting insert, more precisely perpendicularly to the feeding direction of the first milling cutter. In doing so, the two ridges 19 are produced, which extend between  
25           opposed side surfaces of the cutting insert. Between each individual transverse ridge 19 and a nearby set of longitudinal ridges 18A, 18B, secondary transverse ridges 19A and 19B, respectively, are also present. These ridges do not have full cross-section along the entire length  
30           thereof, but are intersected by more or less deep part slots 24, which constitute extensions of the grooves 22, and are produced in connection with raising and lowering, respectively, of the first milling cutter, which creates the ridges 18A, 18B. By the existence of these countersinks 24, the male-like formations 19A, 19B obtains at least  
35           partly the character of pyramid-like tops, rather than continuous ridges.

It is of course also feasible to form the sets of ridges in the opposite order, i.e., first the transverse ridges 19 and then the longitudinal ridges 18.

11977wo 2005-02-21

8

In the embodiment shown in fig. 4, all ridges are equally high. More precisely, the crests 21 on all ridges 18A, 18B, 19, 19A and 19B are located in a common plane (that is parallel to the top side 7 of the cutting insert). However, it is also feasible to locate the ridges, or at least the crests thereof, in different planes. One such embodiment is exemplified in fig. 5, in which a number of transverse ridges 19 in the connecting surface 3 serving as insert seat are located in another plane than the ridges 18A, 18B. More precisely, the transverse ridges 19 are countersunk in relation to the longitudinal ridges 18A, 18B. It should be made clear that the level difference between the respective ridges primarily consists of the crests of the ridges being located in different planes. This may be the case even if the ridges in the respective surface fields have different depth or height. The embodiment shown in fig. 5 is particularly advantageous, so far that the crests of the ridges 19 are located in flush with or under the bottoms of the grooves 22, which are present between the ridges 18A, 18B. In such a way, the manufacture can be carried out without any jumping motions of the milling cutter. Thus, in a first operation, it is possible to bring the milling cutter in one plane from one end of the insert seat to the opposite, after which a second milling cutter is brought to move perpendicularly to, and on a lower level than the first milling cutter, so as to form the transverse ridges 19. In doing so, in the basic body, a central countersink 25 is formed, which along opposed edges is delimited by shoulder surfaces 26. If desired, said shoulder surfaces 26 may be utilized for purposes of transfer of force by being formed with close fit in relation to two edge surfaces 27 on a female portion 28 protruding from the bottom side of the cutting insert, which female portion carries transverse ridges 19 and has the same basic shape as the countersink 25.

In the example according to fig. 5, the cutting insert 2 is indexable in only two positions. For this reason, instead of a waffle-patterned serration connecting surface, a connecting surface 5 may be used that, like the



11977wo 2005-02-21

9

insert seat3, comprises two mutually spaced-apart sets of longitudinal ridges 18A, 18B, as well as transverse ridges 19 between the same, the transverse ridges 19 being formed on the female portion 28.

5           Finally, in fig. 6, an alternative embodiment of a cutting insert 2 is shown, which on the bottom side thereof has two spaced-apart sets of longitudinal ridges 18A, 18B, as well as one set of pyramidal tops 16, which are arranged in a plurality of (five) transverse rows for the co-  
10           operation with complementary transverse ridges 19 in an insert seat3.

          The number of longitudinal and transverse ridges, respectively, in the sets of ridges, which together form a serration connecting surface, may vary most considerably.  
15           However, generally, the number of longitudinal ridges should be considerably larger than the number of transverse ridges. In practice, the number of longitudinal ridges may, accordingly, be at least 10, or even 20 times larger than the number of transverse ridges. This is for the total area  
20           of the active flanks of the longitudinal ridges (one on each individual ridge) to become many times larger than the total area of the force-carrying flanks of the transverse ridge or ridges. The number of transverse ridges may advantageously be as small as 1, although also variants of  
25           2-6 transverse ridges are feasible, as has been exemplified in the drawings. The absolute number of longitudinal ridges in each one of the two surface fields A, B may advantageously amount to 10 or more.

11977wo 2005-02-21

10

List of Reference Designations

- 1 = basic body  
2 = cutting insert  
3 = serration connecting surface (insert seat)  
5 4 = chip pocket  
5 = serration connecting surface (on cutting insert)  
6 = screw  
7 = top side of cutting insert  
8 = bottom side of cutting insert  
10 9 = side surfaces  
10 = major cutting edge  
11 = wiper edge  
12 = front surface  
13 = envelope surface  
15 14 = fixing portion  
15 = active corner on cutting insert  
15A = corner in insert seat  
16 = serration tops  
17 = grooves  
20 18 = longitudinal ridges  
19 = transverse ridges  
20 = flanks of ridge  
21 = crest of ridge  
22 = grooves  
25 23 = bottom of groove  
24 = slots of groove  
25 = countersink in insert seat  
26 = shoulder surfaces  
27 = edge surfaces  
30 28 = female portion